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**Dedicated to James Scudday,
devoted mentor, and natural historian.**

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HISTORIC AND CURRENT DISTRIBUTION AND ABUNDANCE OF WHITE-WINGED DOVES (*ZENAIDA ASIATICA*) IN THE UNITED STATES

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ABSTRACT.—White-winged Doves in the U.S. have occurred in breeding populations throughout the Southwest. Two populations, western and eastern, are designated with western White-winged Doves occurring primarily in Arizona and eastern White-winged Doves primarily in Texas. In the past century, western White-winged Dove populations have remained relatively stable in distribution and abundance with some change in distribution. However, the eastern White-winged Dove has dramatically expanded its breeding range northward. Changes in natural history have come with the range expansion of eastern White-winged Doves, most notably the establishment of urban populations of which large proportions have become non-migratory. These issues are described and discussed and population trends are examined.

INTRODUCTION

This treatise provides a current and comprehensive account of the distribution and abundance of White-winged Doves (*Zenaida asiatica*) in the U.S. Publications on natural history and ecology of White-winged Doves are available, but are either outdated or incompletely address their distribution and abundance. In particular, Cottam and Trefethen (1968), George et al. (1994), and Schwertner et al. (2002) are excellent references, although broad in scope. Hence, we believe the need for this work is warranted.

Natural History—White-winged Doves (*Zenaida asiatica*) are medium-sized New World columbids. They are distinguishable from other sympatric doves by pronounced white wing patches on the upper-wing coverts (Figure 1). They have a squared-off tail, unlike conspecific Mourning Doves (*Zenaida macroura*), which have pointed tails. Adults also exhibit a bright orange iris with the eyes surrounded by a bare patch of blue skin. The majority of White-winged Doves typically nest in northern Mexico and southwestern U.S. between mid-April and August. Nests generally consist of flimsy platforms of twigs and sticks in forks of tree branches. Historically, White-winged Doves preferred Texas ebony (*Chloroleucon ebeno*), granjeno (*Celtis pallida*), anacua (*Ehretia anacua*), brasil (*Condalia hookeri*), coma (*Sideroxylon celastrinum*), tenaza (*Havardia pallens*), Wright acacia (*Acacia greggii*), lime prickly-ash (*Zanthoxylum fagara*), Texas persimmon (*Diospyros texana*), guayacan (*Guajacum angustifolia*), and tepeguaje (*Leucaena pulverulenta*) as nest sites (Schwertner et al. 2002). Clutches consist of 2 eggs (occasionally 1 or 3) with incubation lasting about 14 days (Schwertner et al. 2002). Eggs usually hatch on consecutive days with fledging occurring in about 14 days. Both parents participate in nest building, incubation, and brooding with males attending the nest for most of the diurnal period and females caring for the nest nocturnally (Cottam and Trefethen 1968).

Morphological Variation—White-winged Doves exhibit a relatively broad range of morphological characteristics with an extensive degree of overlap. However, individuals in the western population are generally larger than eastern White-winged Doves (Gallucci 1978). In the U.S. the largest White-winged Doves occur in the Trans-Pecos region of Texas and commonly weigh > 200 g, while the smallest occur along the coast of the Gulf of Mexico and tend to weigh about 160–170 g. (Small pers. obs.). White-winged Doves also exhibit variations in coloration with individuals generally becoming gradually darker the farther west.

Range—Prior to 1900, the range of White-winged Doves in the U.S. was limited to riparian areas of the Southwest primarily in extreme southern Texas, New Mexico, Arizona, and California (Cottam and Trefethen 1968). Outside the U.S. White-winged Doves range from Mexico into northern South America and eastward to some Caribbean islands (Figure 2). Vagrants have been recorded as far north as Alberta, Canada (Table 1).

Taxonomy—The species is polyphyletic with 12 subspecies recognized (Saunders 1968), 4 of which are purported to occur in the U.S. The validity of the 12 subspecies proposed by Saunders (1968) was questioned (Browning 1990) because the taxa were differentiated based on small, often overlapping, phenotypic variation. Later, Baptista et al. (1997) and the American Ornithological Union (1998) combined these into 4 subspecies comprising 2 groups;



Figure 1. A White-winged Dove exhibiting the species distinctive appearance.

the *asiatica* group consisting of 3 subspecies in North America and the *meloda* group with 1 subspecies occurring along the Pacific coast of South America. The *meloda* group is now considered a separate species (*Z. meloda*) by the American Ornithological Union (2002). Nuclear and mitochondrial DNA analyses support the separation of *Z. meloda* and *Z. asiatica* as well as the separation of *Z. asiatica* into 2 groups, western and eastern White-winged Doves (Johnson and Clayton 2000a, b). Additionally, analysis of mitochondrial DNA by Pruett et al. (2000) concurs with the assessment by Johnson and Clayton (2000a, b) that *Z. a. mearnsi* represents a western subspecies and *Z. a. asiatica* represents an eastern subspecies. In this paper, we follow the latter taxonomic scheme for White-winged Doves in the U.S. as a western subspecies (*Z. a. mearnsi*) and an eastern subspecies (*Z. a. asiatica*).

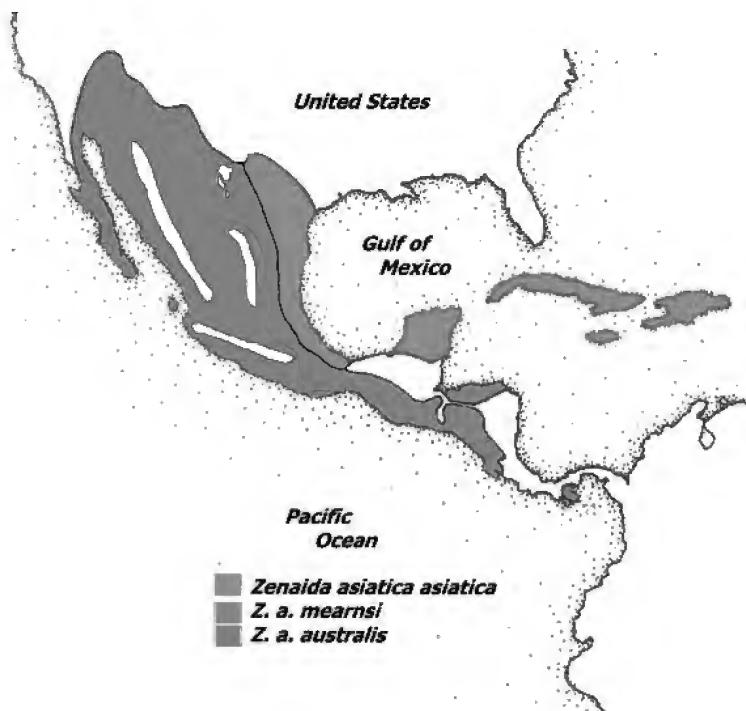


Figure 2. Probable range of the White-winged Doves [circa 1900] (based on information reported by Wetmore 1920, Bent 1932, and Saunders 1940, 1968) identifying the 3 currently recognized subspecies.

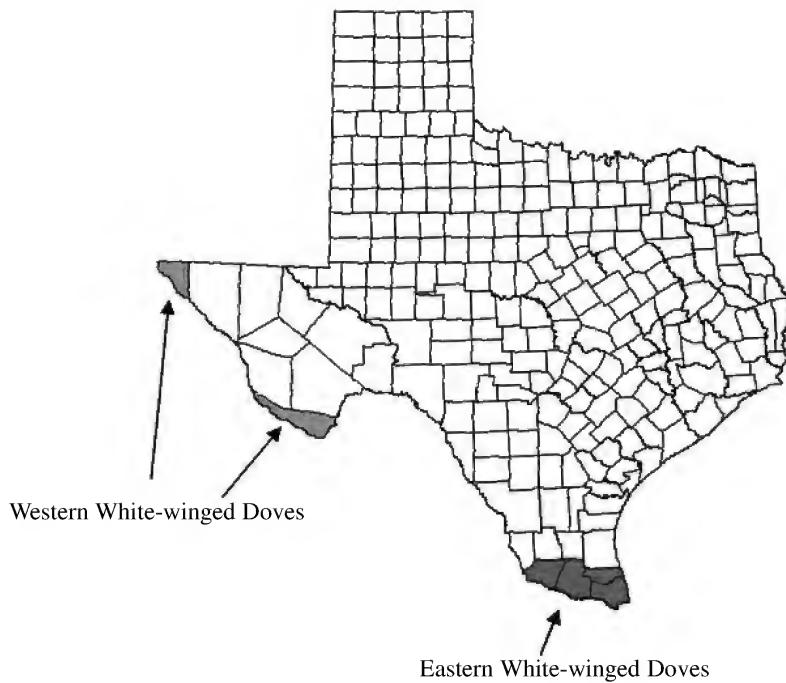


Figure 3. The principal range [circa 1900] of breeding White-winged Doves (eastern and western) in Texas (Wetmore 1920, Bent 1932, Saunders 1940, 1968, Cottam and Trefethen 1968).

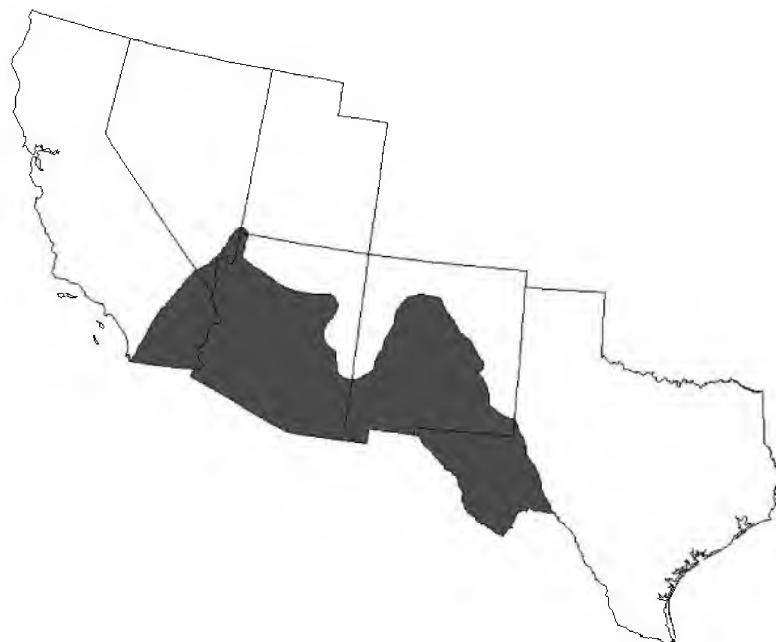


Figure 4. Principal breeding range of the western White-winged Dove in the U.S. (based on 2005 Breeding Bird Surveys, Texas Parks and Wildlife Department, Arizona Game and Fish, and New Mexico Department of Game and Fish information).

Western White-winged Doves

The western subspecies (*Z. a. mearnsi*) historically occurred in the Trans-Pecos region of Texas (Figure 3), westward through southern New Mexico, much of Arizona, and restricted portions of Nevada, Utah, Colorado, and southern California (Butler 1977) (Figure 4). Higher population densities were associated with riparian habitats in harsh, desert environs (Cottam and Trefethen 1968). The greatest concentration of the breeding population occurs in the Sonoran Desert of Arizona (Neff 1940a, Pacific Flyway Council 2003). Here they nest colonially along the Colorado River and its tributaries in exotic salt cedar (*Tamarix* sp.) and native mesquite (*Prosopis* sp.) (Cunningham 1986). Also in Arizona, a unique population of solitary nesting White-winged Doves closely matches the distribution of saguaro cactus (*Carnegiea gigantea*), which they depend upon for food and water (Haughey 1986) through the consumption of nectar, fruits, and seeds (Wolf and Martinez del Rio 2000). Western White-winged Doves also are important pollinators (Wolf and Martinez del Rio 1998) (Figure 5) and dispersers of seeds for saguaros (Olin et al. 1989). It is reasonable to assume this co-evolutionary relationship between western White-winged Doves and saguaros evolved because saguaros bloom and produce fruit every year, regardless of varying climatic conditions (George et al. 1994). In Sonora, Mexico White-winged Doves also nest in pipe organ cactus (*Stenocereus thurberi*) and cardon cactus (*Pachycereus pringlei*), but the level of association has not been determined (Russell and Monson 1998).

Eastern White-winged Doves

The eastern subspecies (*Z. a. asiatica*) historically occurred in the lower Rio Grande Valley (LRGV) of Texas. The LRGV (Starr, Hidalgo, Cameron, and Willacy counties) includes the terminal reach of the Rio Grande. Eastern White-winged Dove habitat in the LRGV is part of the Tamaulipan Biotic Province (Blair 1950), which is composed of several biotic districts. These biotic districts composed of numerous biotic communities (Jahrsdoerfer and Leslie 1988) have been categorized as nationally significant (USFWS 1980), including the Falcon Woodland, which is ranked fifth in the top 100 nationally significant fish and wildlife areas (Butterwick and Strong 1976).

Eastern White-winged Dove populations suffered severe declines beginning about 1920, the time identified as the beginning of large-scale habitat destruction from agricultural production in the LRGV (Oberholser 1974, Purdy and Tomlinson 1982). Large tracts of land were cleared for production of citrus, sorghum, cotton, and other crops. This agricultural production required tremendous amounts of irrigation water from the Rio Grande, causing the water table to drop. Additionally, populations of municipalities began growing in the LRGV at the same time, also increasing water requirements. The combined effect of agricultural and municipal water use exacerbated the loss of native vegetation and White-winged Dove nesting habitat, especially along the Rio Grande River (Figure 6).

Eastern White-winged Doves in Texas are occasionally solitary nesters, particularly in scrub-thorn areas away from riparian and urban areas. However, the vast majority of White-winged Doves nest in large colonies

Table 1. List of states/provinces where eastern White-winged Doves have been sighted outside their traditional breeding range with associated citations in chronological order.

Georgia	Patterson 1984	Alberta	Rogers 1998
Georgia	Brisse 1985	Iowa	Proescholdt 1998
Oklahoma	Brewer 1987	Iowa	Hultine 1998
Georgia	Waters 1988	Pennsylvania	Pulcinella 1998
Michigan	Evers 1989	Connecticut	Mantlik et al. 1998
Maryland	Rambo 1990	Alberta	Slater 1999
Oklahoma	Newell 1991	Wisconsin	Cowart 2000
South Dakota	Williams 1994	Ohio	Berner 2001
South Carolina	Buhlmann et al. 1995	Indiana	Gorney 2003
Minnesota	Nicoletti 1995	Minnesota	Stephenson 2003
Pennsylvania	Pulcinella 1996	Kentucky	Palmer-Ball 2003
Wisconsin	Cowart 1998	Illinois	Watson 2004

in riparian habitat along the Rio Grande River. More recently established urban populations north of the LRGV also nest in large colonies, often with multiple nests in a single tree (Small pers. obs.). The densest breeding populations of White-winged Doves occur in northeast Mexico, particularly in Tamaulipas (Blankenship 1970). These Mexican populations of White-winged Doves suffered severe declines during the 1970s with over-hunting identified as the primary cause for the population reduction (Bautista and Brito 1992). However, population estimates indicated the northeast Mexico population more than doubled in size during the 1980s (Bautista and Brito 1992), coinciding with White-winged Dove population expansion in Texas and an increase in recently colonized urban White-winged Dove populations in Texas (Figure 7). Whether these events are correlated has not been determined.

METHODS

We examined the historic and current status of White-winged Doves in the U.S. based on available information. Much of what is known, or thought to be known, about the species has been based on information accepted as empirical, which after closer scrutiny, has been shown to be at least partially anecdotal. Our purpose is to provide a current, comprehensive account of changes in White-winged Dove populations and distribution in the U.S., and discuss the dynamics and subsequent implications associated with these changes. The need for a contemporary examination of the status of White-winged Doves in the U.S. is based primarily on a recent, perceived decline of White-winged Doves in the LRGV of Texas and northward expansion of eastern White-winged Doves (Purdy and Tomlinson 1991, Waggoner 1992, Small and Waggoner 1999). We also discuss the urbanization and migratory status of White-winged Doves (Schwertner et al. 2002). Our working assumption is that relatively recent changes in White-winged Dove natural history, particularly distribution and abundance, are not the result of any single factor (Schacht et al. 1994, Hayslette et al. 1996, 2000, Burkepile et al. 2002) but a combination of multiple factors.

We reviewed literature pertaining to White-winged Doves in the U.S. In some cases, we reanalyzed and/or reinterpreted published data to more accurately present findings and emphasize relevant issues. Much information was also available from the National and Texas Audubon Societies. In addition, we reviewed on-going research on White-winged Doves in Texas.

Public Participation—We also took advantage of considerable public interest in bird species, primarily by bird-watchers and conservation organizations but also by individuals interested in learning about birds (Figure 8). Innovative conservation groups and clubs have teamed with biologists to collect data on bird species in what has been coined “citizen science.” At the forefront of this effort has been the Audubon Society, in conjunction with other institutions, which sponsor programs such as Christmas Bird Counts (CBC), the Great Backyard Bird Count (BBC), and eBird (<http://www.ebird.org/content/>) (National Audubon Society 2002).

By far the most ambitious undertaking is the CBC, which is an annual event with over a century of history. Volunteers identify birds for 1 day between mid-December and early January for a given area and then submit the results into a database. Trends in early-winter bird populations can then be analyzed, albeit with care, given variation in observer ability and effort. To date, over 6 million birds have been reported for the 106th (2005–2006) CBC (National Audubon Society 2006). An analysis of the benefits and problems associated with data obtained from the CBC are discussed by Root (1988).

The most useful aspect of the CBC is the number of individuals of a particular species sighted per party-hour effort (number of individuals sighted per survey). If a species is encountered more often per unit effort over time, it is plausible to infer that the species is either becoming more numerous and/or expanding its range. Conversely, the opposite could be inferred. If no correlation is shown, then it is plausible that the population is stable in size and range, unless otherwise determined. Although subject to potential bias, large sample sizes allow data to be treated as credible provided caution is used in drawing conclusions. Additionally, because the CBC is conducted in winter, and because White-winged Doves are historically migratory, an increase in number observed per party-hour may represent the establishment of resident populations. Low observation per party-hour indices and a lack of correlation over time may be indicative of the presence of over-wintering stragglers.

For purposes of this study, we compared the number of count circles over time. We scored the data by number of birds sighted per survey. We scored data by multiplying surveys with ≤ 10 individuals by 1, $> 10\text{--}50$ by 2, $> 51\text{--}100$ by 3, $> 101\text{--}500$ by 4, and > 500 by 5 and summing the results by year. We then compared scores over time.



Figure 5. Western White-winged Dove on a Saguaro cactus. Photo by Rick and Nora Bowers @ Vireo.

We used annual Audubon Christmas Bird Counts (CBC), the North American Breeding Bird Survey (BBS) (Sauer et al. 2005), and the Texas Breeding Bird Atlas (BBA) (Benson and Arnold 2001) as sources of data. A bibliography of publications using CBC data can be found at <http://www.audubon.org/bird/cbc/biblio.html>.



Figure 6. A typical example of riparian habitat loss to agriculture in the lower Rio Grande Valley of Texas. Photo by TPWD.

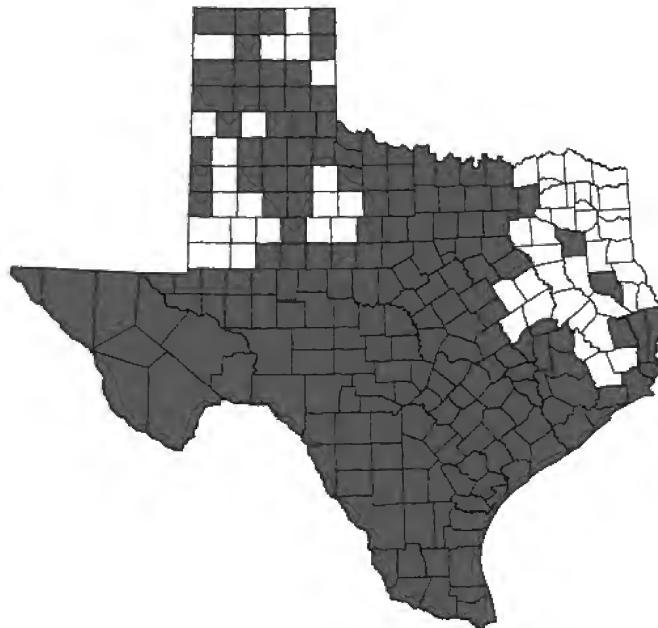


Figure 7. Counties in Texas in which breeding White-winged Doves have been confirmed as of 2005 (based on observations by Texas Parks and Wildlife Department personnel).

RESULTS

Western White-winged Doves

The historic status of western White-winged Doves compared to the present is difficult to ascertain because early explorers were uncommon in the harsh desert environments of the region. This is particularly true of summer months when White-winged Doves arrive to breed from wintering grounds in Mexico and Central America. In addition, Native American tribes were particularly wary of Anglo settlers and intensely defended the region against settlement (Sykes 1944).



Figure 8. An example of public interest in avian research at a young age.

Historic Population: Pre-European Settlement–1920—In Trans-Pecos Texas, White-winged Doves occurred in riparian habitat along the Rio Grande River, nearby streams, and mountain springs (Cottam and Trefethen 1968, Gallucci 1978). In New Mexico and Nevada, the early status of the species is unknown (Schwertner et al. 2002). In southern California, White-winged Doves originally occurred in small numbers, primarily isolated to desert springs and a few riparian corridors along the Colorado River (Brown 1989). Evidence suggests, however, that White-winged Doves may not have occurred in California prior to the development of major irrigation projects in the Salton Sink region in 1900 (Neff 1940b). The Salton Sea, a large lake in the midst of the Mojave Desert, was originally Lake Cahuilla, a seasonally intermittent lake. During construction of the Salton Sink irrigation project, a levy failed, creating what is now a perennial lake (Stringfellow 2005).

The extent White-winged Doves historically inhabited Arizona is also unclear (Phillips et al. 1964, Brown 1989). Native Americans in pre-Anglo settlement Arizona were primarily farmers, unlike hunter-gatherer tribes to the east. Some of these tribes developed sophisticated farming practices including the building and use of substantial irrigation systems (Cottam and Trefethen 1968). This alteration of the natural landscape may have made the area more attractive to White-winged Doves by providing agricultural grains, vegetables, and fruits as food resources. In addition, irrigation would have provided a reliable source of water and associated nesting habitat for breeding White-winged Doves.

Brown (1989) suggested that White-winged Doves were numerous in Arizona at the time of Anglo settlement. If so, it is reasonable to assume they would have provided a readily available food resource to the inhabitants. Yet, archeologists have recorded only 1 White-winged Dove bone from excavations of these early settlements, despite substantial evidence of other bird species (Gallizioli 1955). However, some groups of Indians from the area did not include turkeys and doves in their diets (Ruecking 1953). Therefore, the prehistoric status of White-winged Dove in Arizona remains uncertain.

Mid 20th Century: 1920–1970—Western White-winged Doves in Arizona most likely reached their highest numbers and density in the late 1960s with high numbers occurring in and around Phoenix and Tucson and the vicinity of Lake Havasu along the Colorado River (Wigal 1973). The western White-winged Dove, unlike the eastern population, underwent moderate changes in distribution during this period (Wetmore 1920) primarily with an increased breeding range (Davis and Jenks 1983).

The change in distribution of western White-winged Doves seemed associated with salt cedar, an exotic tree introduced from Eurasia by Anglo settlers, which became established along waterways, stock tanks, and springs (Arnold 1943). Salt cedar displaced many native species, such as cottonwoods (*Populus* sp.), willows (*Salix* sp.), and ash (*Fraxinus* sp.), forming a monoculture in many areas (Wilkinson 1972). Salt cedar and other non-native invaders were considered at first an enhancement to White-winged Dove habitat because of the relatively quick formation of large nesting colonies using salt cedar as nesting trees. However, the long-term detrimental effects of salt cedar to the ecosystem as a whole caused increased awareness and subsequent concern. Salt cedar eventually became regarded as a noxious species (Skagen et al. 1998). In addition, despite the popularity of salt cedar as nesting trees, the level of productivity of White-winged Doves using these trees is not known and suspected to be lower than in native species because salt cedar limbs are flimsy compared to native trees, and dense thickets of salt cedar have extremely high interior temperatures (Engel-Wilson and Ohmart 1978). Salt cedar thickets also harbor large numbers of insects, such as mosquitoes, which feed on nestling White-winged Doves (Engel-Wilson and Ohmart 1978).

Other factors may have adversely affected the distribution of western White-winged Doves beginning in the mid to late 1950s. Increased urban and suburban development and reclamation projects, which accompanied human population growth in the region, contributed to a loss of nesting habitat (Best et al. 1979). Also, changes in agricultural practices converted traditional nesting areas to farmland (Conine et al. 1979). This effect was compounded when economic changes caused a shift in the production of grain crops (corn, sorghum, and sunflowers, which were readily used as a food source by White-winged Doves) to cotton production (George et al. 1994). Finally, the growth of the metropolitan Phoenix area was linked to increased hunting pressure as well as a reduction in citrus groves, which White-winged Doves had begun using as nesting habitat as land was cleared to accommodate increased housing developments (Johnson and Lowe 1985). In contrast, solitary nesting western White-winged Doves seem to have been largely unaffected by these changes (Gilman 1911, Hensley 1954).

Current Population: 1970–Present—In Trans-Pecos Texas, White winged Doves were first documented

outside their historic range in the late 1960s. Notably, in 1968 White-winged Doves were first documented in Alpine, Texas (Brewster County) and first observed nesting in 1973 (Scudday et al. 1980), about 150 km northwest of their historic range in the Big Bend of the Rio Grande River (Engel-Wilson and Ohmart 1978). They have since spread throughout the entire Trans-Pecos region establishing urban populations. The first study of urban-nesting White-winged Doves in Alpine, Texas showed that ornamental trees, in particular Arizona cypress (*Cupressus arizonica*), were important for nesting (Small et al. 1989). In New Mexico, White-winged Doves occur in the southwestern corner of the state (Jenks 1983). They are resident in urban areas and summer residents locally in the south where they are considered rare to fairly common. They are casual to occasional elsewhere in winter and farther north (Hubbard 1978, Williams 1993), including Albuquerque where they have occurred since about 1990.

In California, current White-winged Dove distribution ranges from the Colorado River along the Arizona border where it is fairly common, westward into the Mohave Desert where it is less common, north as far as Joshua Tree National Monument (Garrett and Dunn 1981). The species is present, but rare, along the Pacific coast and occasionally on channel islands and has been recorded as far north as Humboldt County on the west side of the Sierra Nevada Mountain Range (McCaskie et al. 1979). On eastern slopes of the Sierra Nevada, White-winged Doves occur north to Mono County (McCaskie et al. 1979). In California, White-winged Doves are found in riparian desert washes in association with succulent shrubs, desert scrub, alkali scrub, and Joshua tree habitat (Haughey 1986). The species also is found in areas associated with agriculture, primarily orchards, vineyards, and grain crops (Bent 1932).

In Colorado, White-winged Doves are considered casual in spring, summer, and fall on the eastern plains and accidental in mountain parks, urban, grassland, and native scrub habitats (Andrews and Righter 1992). White-winged Doves are considered rare in Utah, occurring primarily in the southwestern corner during summer (Tekiela 2003). They inhabit riparian woodlands, mesquite thickets, and urban residential areas in arid regions (Ehrlich et al. 1988). Breeding White-winged Doves in Nevada are primarily restricted to the southeastern portion of the state (Titus 1996). Currently, White-winged Doves are a legal game bird in all these states.

In Arizona, the majority of White-winged Doves consist of 2 general populations based on breeding gregariousness and associated habitat (Stair 1970). An exception is urban nesting White-winged Doves, which in recent years have reached high densities by relying heavily on anthropogenic food and water from bird feeders and municipal water run-off (Stair 1970). Some of these doves have become resident non-migrants, most likely nesting year-round (Coorman and Wise-Gervais 2006).

Males of scattered, transient populations begin courtship in late April and early May. The first is a scattered population that nests in solitary pairs throughout the Sonoran Desert (Turner and Brown 1982) and the surrounding countryside (including towns and residential neighborhoods). The majority of these solitary nesting White-winged Doves breeds only once and migrates to their winter range prior to early September and beginning of the dove hunting season.

A second population of breeding White-winged Doves in Arizona is colonial and generally nests along river bottoms, usually in close proximity to agricultural areas. Colonial White-winged Doves usually nest twice before departing for wintering habitat in southwestern Mexico (Bertin et al. 1983). These White-winged Doves are most often present after September and contribute most to hunter harvest.

Eastern White-winged Doves

Prior to the implementation of standardized surveys, estimates of White-winged Dove distribution and abundance in Texas were based on local population estimates made by naturalists and biologists. The LRGV population of White-winged Doves historically has been the largest population not only in Texas but in the U.S. (George et al. 1994). Call count surveys to estimate eastern White-winged Dove population size by the Texas Parks and Wildlife Department (TPWD) began in the LRGV sometime around 1940. Currently, call-counts are still being conducted.

Feeding flight count surveys were added about 1966 near 35 traditional roosting sites (Waggerman 1992). Feeding flight surveys were conducted in August and early September. Surveys consisted of trained observers estimating the number of White-winged Doves making early feeding flights over a pre-specified period of time. Because observer bias correlates poorly with production estimates, data primarily were used to monitor annual trends in numbers of White-winged Doves (George et al. 1994).

Call count surveys indicated an estimated peak breeding population of about 1,000,000 around 1950 and a low of about 299,000 in 1990 (George et al. 1994). Call count surveys were expanded in 1961 through 2002 to eventually include 49 counties extending from the LRGV north to Val Verde County in the west and eastward to Travis County in south-central Texas. Outside the LRGV, survey effort focused particularly on Bexar and adjacent counties comprising the San Antonio metropolitan area (George et al. 1994).

Historic Population: Pre-European Settlement—1920—The earliest reliable accounts of observations of eastern White-winged Doves were provided by Sennett (1878, 1879) as part of what may have been the first serious ornithological study of the LRGV. Human impact on White-winged Dove habitat in the LRGV was probably less than in other regions of the U.S. because early Native Americans in the region subsisted primarily by hunting and fishing as opposed to agriculture (Cottam and Trefethen 1968). Also, water was not a limiting factor for White-winged Doves in the region because of the humid climate, regular annual precipitation, and presence of the Rio Grande River. Even following establishment of Spanish missions in the mid-1700s (Kress 1931) and the expansion of European settlements in the mid-1800s, human impact on wildlife habitat was less than in other areas of North America (Dresser 1866) because the economy of the area relied primarily on open-range cattle grazing as opposed to irrigation farming, which required the clearing of large tracts of native vegetation (Sennett 1878).

Even as more modern agricultural practices were introduced into the LRGV by European settlers in the late 1800s-early 1900s, the benefit of increased forage from agricultural grain fields countered the detrimental effects of breeding habitat loss in years of normal climatic conditions (Smith 1910). Prior to 1920, the White-winged Dove population was estimated in the millions (Kiel and Harris 1956). Declines in the White-winged Dove population began after 1920, when large-scale habitat destruction for agricultural production and urbanization began in the LRGV (Oberholser 1974).

Mid 20th Century: 1920–1970—White-winged Doves in their historic breeding range of the LRGV underwent their greatest fluctuation in population size from about 1920 to 1970. Severe drought in the 1930s may have contributed to population declines as fall feeding flight estimates dropped to 500,000 by 1938 and 200,000 by 1940 (Kiel and Harris 1956). Initially, irrigated grain farming may have contributed to an increase in White-winged Dove numbers, which reached a peak estimate of 4–12 million in 1923 (Saunders 1940, Marsh and Saunders 1942, George et al. 1994). The wide range of this estimate likely resulted from doves in the adjacent Mexican state of Tamaulipas being included in some counts.

White-winged Dove numbers then began a substantial decline attributed primarily to large-scale conversion of native brush essential for breeding habitat to agricultural production in the region (Saunders 1940, Cottam and Trefethen 1968, Oberholser 1974). The decline was exacerbated by overharvest and increased urban development (George et al. 1994). However, beginning in the 1940s, large tracts of land were converted to citrus orchards and White-winged Doves adapted to nesting in these orchards in large colonies. By 1950, an estimated 1,031,000 White-winged Doves inhabited the LRGV with > 80% nesting in citrus orchards (Cottam and Trefethen 1968).

However, White-winged Doves nested only in mature citrus trees. Because of the susceptibility of citrus trees to freezing, trees of several citrus species were killed in high proportions by a series of severe freezes. Severe freezes in 1950–1951 and 1961–1962 decimated citrus orchards (i. e., > 85% of mature trees were killed during winter 1950–1951). Concurrent declines in numbers of White-winged Doves followed resulting in closed hunting seasons from 1954–1956 and 1963 (Cottam and Trefethen 1968, George et al. 1994).

White-winged Dove populations recovered somewhat in the 1960s; however, population estimates by the TPWD did not become standardized until 1966, preventing annual trend analysis. Annual population indices are missing prior to 1966, and reports of White-winged Dove population size were based on estimates made by various researchers using unknown or varying methodology. However, many of these researchers were respected ornithologists, and these estimates often are used because they represent the only available information for the period.

It was during this period that White-winged Doves began moving northward, expanding their breeding range. In at least one instance humans contributed directly to the range expansion. In the 1930s, a prominent attorney from Beeville, Texas (Bee County) brought White-winged Doves from Mexico to Beeville and two other south Texas locations in hopes of establishing the species in the area. Of these the Beeville population became established and a breeding population appeared to be doing well by the 1950s.

There has been some speculation that the Beeville White-winged Doves may have contributed to the establishment of other urban populations throughout the state. We contend that the Beeville population could have

contributed to the range expansion, but only minimally, primarily because genetic studies indicate that both western and eastern White-winged Doves contributed to the range expansion populations (Pruett et al. 2000).

Current Population: 1970-Present—Although White-winged Doves began expanding their range northward in Texas beginning about 1950, it wasn't until about 1970 that the range expansion included relatively large numbers over increasing distance (Small et al. 1989, 2005). The most notable aspect of the White-winged Dove range expansion is that breeding populations outside traditional breeding areas are almost exclusively restricted to urban areas and portions of these urban populations have become non-migrant residents (Small et al. 1989, 2005, Schwertner et al. 2002, Schaefer et al. 2004).

White-winged Dove range expansion has been particularly extensive in central Texas. In 1990, estimates of breeding White-winged Doves outside the LRGV exceeded estimates for the LRGV for the first time (George 1991, George et al. 1994). In 1993, West et al. (1993) reported an estimated breeding population of > 1 million individuals within the San Antonio metropolitan area (Bexar County) based on call counts and nest transects. Texas Parks and Wildlife Department estimates for the same period indicated only about 410,000 birds. This disparity may be because the lower estimate refers to breeding pairs or the inclusion of transects by West (1993) resulted in the difference in estimates. In Waco, Texas (McClellan County) northeast of San Antonio, White-winged Doves were first recorded in 1988 and first observed breeding in 1993 (<http://www.ebird.org/content/>). Coo-count surveys in Waco conducted by TPWD personnel from 1999–2003 derived an estimated breeding population of about 70,000 White-winged Doves (Small et al. 2005).

White-winged Doves were at first periodic summer residents in the northern portions of their range expansion, departing in the fall, presumably to warmer areas to the south. However, they began over-wintering in the 1980s and 1990s in measurable numbers and currently the majority of these populations have become non-migratory residents. White-winged Doves in the range expansion area are invariably associated with humans and occur and nest in suburban areas. They are common visitors to backyard feeders (Figure 9) and use municipal run-off as a major source of water, although they often make feeding flights to nearby agricultural fields, particularly in the fall when flocking behavior is at its peak (Small pers. obs.). We believe it is probable that the availability of reliable, year-round, anthropogenic food and water sources are 1 reason these populations have become non-migratory, at least in the traditional sense, although physiological factors probably contribute to the phenomenon (Berthold 1996). Currently, White-winged Dove breeding populations in Texas occur as far north as Lubbock (Lubbock County) and Amarillo (Potter and Randall Counties) in the panhandle and Dallas (Dallas County), Fort Worth (Tarrant County), and Denton (Denton County) in north Texas, east to Jefferson County (Lockwood and Freeman 2004).



Figure 9. White-winged Doves at urban feeder in San Antonio, Texas. Photo by Jack Eitnhear.

Florida Population

Outside of Texas, breeding populations of eastern White-winged Doves established in Florida have expanded into Georgia (Chandler and Lewis 2001). In addition, sightings of White-winged Doves have occurred north along the eastern seaboard, across southern states, and throughout the Midwest north to southern Canada.

White-winged Doves are not native to Florida. Although Aldrich (1981) concluded that Florida White-winged Doves appear to be more closely related to Caribbean individuals than Mexican or Texas birds, Saunders (1980) determined that 10 pairs of White-winged Doves from Mexican stock were released by an individual in Homestead in 1959. These individuals established a successful breeding population, and several years later the Florida Game and Fresh Water Fish Commission (now Florida Fish and Wildlife Conservation Commission) began trapping individuals and releasing them in central Florida as far north as Lake County (Williams 1978).

Florida White-winged Doves now occur in at least 67 counties (Figure 10) with $> 1,000$ roosting individuals reported (Stevenson and Anderson 1994). White-winged Doves sighted along the eastern seaboard and southern states are most likely transients from the Florida population while White-winged Doves sighted across the Midwest most likely represent extensions of the Texas population.



Figure 10. Principal breeding range of White-winged Doves in Florida (based on Breeding Bird Surveys and the Florida Breeding Bird Atlas, 2003).

POPULATION TRENDS

White-winged Doves in both the western and eastern populations have undergone distributional change over about the last 150 years, primarily as a result of anthropogenic influence. Most importantly, White-winged Doves are now present in areas where previously absent. We believe that this is partly because new riparian areas have been established (i.e., impoundments) and because many of the structural components (vegetation) of breeding habitat (traditional riparian areas) now exist in urban/suburban areas. However, this is based on observations and is, at best, a hypothesis that should be tested.

Another concern regarding the expansion of White-winged Doves northward is the potential for disease transmission to other avian species, particularly pigeons and doves. Recent work on White-winged Doves indicates they are host to numerous parasites, yet appear to be predominantly unaffected (Glass et al. 2001, 2002a, b). In particular, Trichomoniasis can have devastating effects on dove populations (Table 2), and the effects of increased sympatry with related species of White-winged Doves should be monitored.

Table 2. Some examples of wild Columbid die-offs from trichomoniasis reported in the scientific literature (from USGS 1999).

Year(s)	Species	Magnitude	Geographic Area
1949–1951	Mourning Doves	Tens of thousand	SE U.S
1950–1951	Mourning Doves	25,000–50,000	Alabama
1972	Columbid sp.	Several hundred	Nebraska
1985	Mourning Doves	~800	New Mexico
1988	Band-tailed Pigeons*	>16,000	California
1991	Mourning Doves	~500	North Carolina

*First major epizootic of trichomoniasis reported in this species.

Western White-winged Doves

The largest population of Western White-winged Doves breeds in Arizona with notable breeding populations in California, Nevada, New Mexico, and Trans-Pecos Texas. Smaller breeding populations also occur in southern Utah and Colorado. All these states allow the harvest of White-winged Doves during hunting season as a proportion of aggregates during Mourning Dove season.

We were unable to find reliable estimates for White-winged Dove population size for these states, however, relative density estimates indicate the vast majority of individuals occur in Arizona (Pacific Flyway Council 2003). In addition, Arizona has collected coo-count index (CCI) data and harvest estimates since 1962 as an indicator of population trends. Harvest data estimates are also available for White-winged Doves in California beginning in 1992 and Nevada beginning in 1999. Harvest data are based on hunter questionnaires (HQ) and are preliminary, therefore, they are subject to some bias, yet still provide useful trend information. Only Arizona has used CCI to estimate trends in White-winged Dove population size.

Arizona and California designated White-winged Doves as a game bird with specific hunting seasons in 1956. In Arizona, bag limits for Mourning Doves and White-winged Doves were separated from 1957–1979. In 1956 and beginning again in 1980, aggregate bags were established in Arizona. In California, aggregate bag limits began in 1956 and have continued to the present. White-winged Dove hunting seasons were established in Nevada in 1956 as well, however, the season was closed until 1961, when separate limits for White-winged Doves and Mourning Doves were established. Aggregate limits in Nevada began in 1962.

Of states with western White-winged Doves, only Arizona conducts CCI. This involves driving random 20-mile routes in May and June, stopping at 1-mile intervals, and recording the number of White-winged Doves heard or seen. In Arizona, from 1962–2003, the CCI indicates a substantial and significant decline in White-winged Doves occurred (Figure 11a). In addition, Arizona Department of Game and Fish conducts surveys of dove hunters using a hunter questionnaire (HQ) program (Figure 11b). Hunters report the number of White-winged Doves harvested. From 1962–2003, Arizona HQ surveys indicated a sharp, significant decline in number of White-winged Doves harvested. California also began using HQ in 1992 to determine trends in White-winged Dove harvest. Data from 1992–2002 revealed an insignificant decline in harvested White-winged Doves (Figure 12). No other data are currently available, however, the Western Management Unit of the Pacific Flyway began implementing a harvest information program in 1999, which is still under development.

Christmas Bird Counts—In Arizona, CBC data for White-winged Doves from 1960–2002 showed a fairly stable population. The mean annual number of count circles was 13.21 (SE = 0.72, minimum = 0.0, maximum = 22). The mean annual number of observations per party-hour was 0.06 (SE = 0.007, minimum = 0.0, maximum = 0.22). Pearson's correlation coefficient showed a lack of relationship between number of circles and number of observations per party-hour over time ($r = 0.21$, $F_{1,40} = 1.83$, $P = 0.18$) and between count circle score and number of individuals per party-hour over time ($r = 0.29$, $F_{1,40} = 3.76$, $P = 0.06$). However, the North American Breeding Bird Survey (NABBS) summary of population change (i.e., coo-count surveys) indicated a slight but insignificant decline in breeding White-winged Doves in Arizona from 1966–2004 (trend = -0.92, $n = 39$, $s = 0.32$, $P = 0.11$).

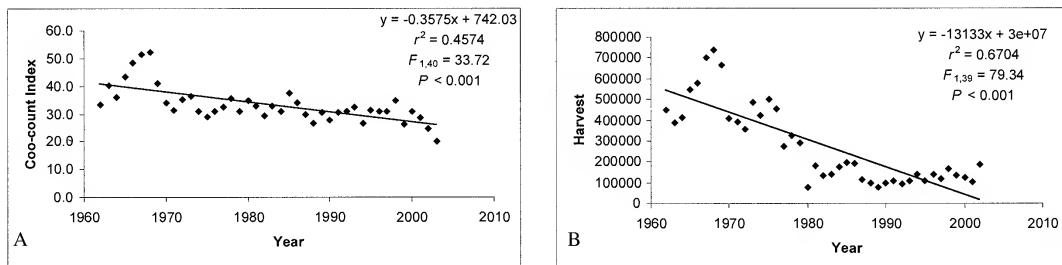


Figure 11. Regressions of (a) coo-count indices and (b) hunter harvest for White-winged Doves in Arizona.

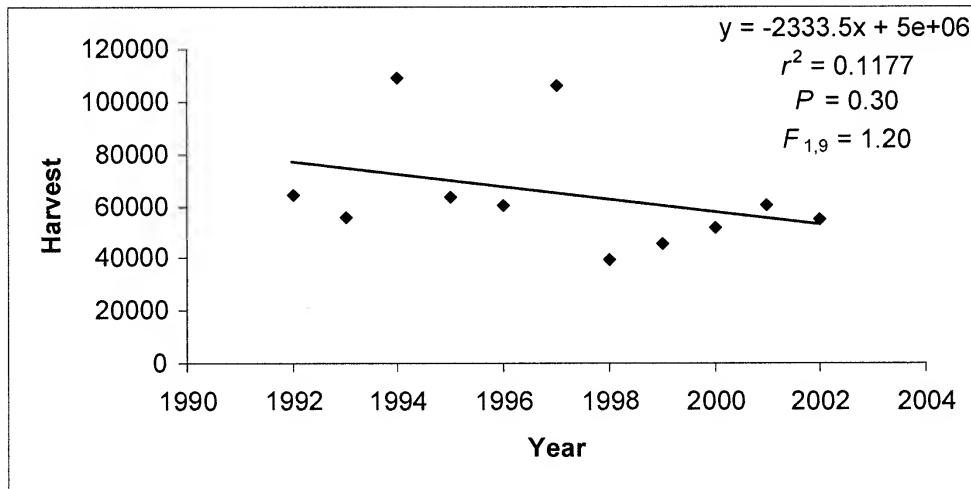


Figure 12. Regression of hunter harvest for White-winged Doves in California.

Eastern White-winged Doves

Population estimates of White-winged Doves in Texas have been conducted by TPWD since around 1940 using coo-count surveys. Although Rappole and Waggoner (1986) reported that these surveys were initiated in 1948, the earliest record we were able to find was a hand-written survey form from 1946. Protocols for surveys were based on coo-counts conducted between 10 May and 10 June beginning no earlier than 30 min prior to local sunrise and completed within 3.5 hr. Tracts (representing a given area), stop location (with a description, i.e., brush, grain field, citrus), and number of calling White-winged Doves heard converted into breeding pairs/acre were recorded for each stop. For tracts \leq 8 acres a single stop location was used. For tracts $>$ 8 acres, stop locations were spaced at 0.5-mi. intervals. Conversion to breeding pair density was arbitrarily established. Call count surveys are still conducted; however, 1-mi. sampling intervals are used. Currently, TPWD is in the process of converting to distance sampling to provide an empirical estimate of White-winged Dove density.

The popularity of coo-count surveys is based on minimum labor, cost, and time. Nevertheless, numerous problems are associated with the use of coo-count surveys for determining White-winged Dove breeding density. Effort varies within and between years, observer bias are not tested or taken into account, and tracts and site locations are not randomly selected. Additionally, comparisons with nest transect surveys, which are comparatively labor, cost, and time intensive, indicated that coo-count surveys significantly overestimated breeding White-winged Dove density (Rappole and Waggoner 1986). Other variables known to affect calling in doves were not adjusted for, including variation in abiotic factors such as weather (LaPerriere and Haugen 1972), individual differences in calling between mated versus unmated males (Baskett et al. 1978), and differences in calling intensity of individuals over time (Waechtler 1977) and in relation to nesting status (Irby 1964).

Caution should be used when analyzing such trend data. We recommend the use of a minimum of 20 data points in any analysis to minimize observer bias and to maximize the effects of the presence or absence of outliers. For instance, correlation of call count data estimates in the LRGV of Texas for 1966–1969 indicate a significant decline in White-winged Doves (annual coefficient = -131400, $r = 0.998$, $F_{1,2} = 407.02$, $P = 0.002$), however, addition of estimates from 1970 are sufficient to indicate the decline was not significant (annual coefficient = -62500, $r = 0.67$, $F_{1,3} = 2.45$, $P = 0.216$). This example demonstrates the need for extreme care when analyzing population trend data for White-winged Doves, particularly with small sample sizes. Because of this, we recommend that any time series analysis be evaluated for the presence of autocorrelation in any linear model of White-winged Dove population trends (Burnham and Anderson 1998).

Christmas Bird Counts—In Texas, CBC data for White-winged Doves from 1961–2003 indicate an increasing and expanding population. Mean annual number of count circles was 13.21 (SE = 2.59, minimum = 1.0, maximum = 66). Mean annual number of observations per party-hour was 0.35 (SE = 0.09, minimum = 0.003, maximum = 2.76). Pearson's correlation coefficient showed a strong, significant relationship between number of circles and number of observations per party-hour over time ($r = 0.92$, $F_{1,40} = 213.84$, $P > 0.001$) and between count-circle score and number of individuals per party-hour over time ($r = 0.88$, $F_{1,40} = 132.13$, $P < 0.001$). In addition, the NABBS summary of population change indicates a substantial but insignificant increase in breeding White-winged Doves in Texas from 1966–2004 (trend = 7.44, $n = 59$, $s = 21.54$, $P = 0.12$).

DISCUSSION

Changes in distribution, including range expansion, of avian species are not a particularly new or unusual phenomenon. However, it is not unreasonable to attribute an increase in occurrence of these changes to anthropogenic influence. Change in avifauna ranges in Europe attributed to climate change was documented as early as 1949 (Kalela 1949). Range expansions in native birds generally occur regionally (Kushlan and Fisk 1972, Smith 1978, Rothstein et al. 1980) and are often associated with wintering populations (James et al. 1987, Aliskauskas 1998). Species introduced to new areas are well known for expanding their range (Owre 1973, Temple 1992, Hengeveld 1993).

Eurasian Collared Doves (*Streptopelia decaocto*) have undergone a dramatic range expansion. Once believed to occur only in India (Hollom et al. 1988), Eurasian Collared Doves, beginning about 1900, and especially in the 1930s, expanded into Europe as far north as Norway, above the Arctic Circle. It is unclear whether they reached Europe (Turkey) on their own, or were introduced by humans around 1600 (Jonsson 1992, Ehrlich 1994).

White-winged Doves in Texas have exhibited a dramatic and punctuated range expansion. The rate of White-winged Dove range expansion began peaking about 1980, or shortly thereafter, but is still continuing. This provides a unique opportunity for research into understanding the causes and effects of this range expansion. The change in distribution and abundance of eastern White-winged Doves, and the lack of similar changes in western White-winged Doves, presents ecologists with a unique opportunity to understand columbid population dynamics. Western White-winged Doves have changed relatively little in range and distribution, perhaps a large proportion share a phenological association with saguaro cactus (Corman and Wise-Gervais 2005).

White-winged doves do not recognize political boundaries, only geographic ones. Therefore, it is not realistic to hypothesize about expansion of eastern White-winged Doves without keeping in mind that they are part of a larger population in Tamaulipas, Mexico. That said, historically, breeding eastern White-winged Doves in the U.S. have been linked to riparian habitat in the LRGV. This habitat has largely been destroyed, beginning in earnest about 1920 with the advent of modern agricultural practices. Subsequently, eastern White-winged Doves have proven to be surprisingly adaptable, establishing urban, resident, breeding populations to the north. Continued research is imperative in understanding the dynamics of this species in the U.S. at multiple ecological levels.

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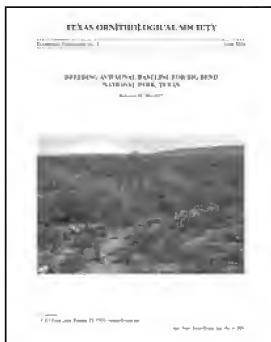
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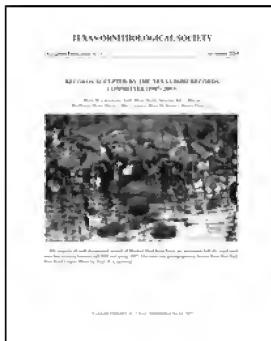
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